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BIRDS AS A FACTOR IN CONTROLLING INSECT DEPREDATIONS

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That North American birds are regarded as a priceless national heritage is shown by the fact that all but a relatively few species (or groups) are protected by Federal law, by international treaty with Canada (Great Britain) and Mexico, or by the laws of the States or the Canadian Provinces.

Birds are useful as protectors of crops and forests through their feeding on destructive insects, as part of Nature's great balancing mechanism, as scavengers, as game, food, or articles of commerce, or merely as objects of beauty and interest. To a people of sentiment, wildlife or other objects of nature need not be associated with the dollar sign in order to receive protection and encouragement. We agree with Emerson that "if eyes were made for seeing, then Beauty is its own excuse for being." The esthetic and recreational values of birds, though largely intangible, are just as real as bank accounts or interest on stocks and bonds. Like a masterpiece of art or an orchestral symphony, they uplift the soul and give meaning and purpose to life. Man is rejuvenated both in spirit and in body by a day afield, enjoying the charm and beauty of the songs of birds, studying the grace and rhythm of their movements, and partaking of their contagious joyousness. E. H. Forbush has well said that "the beauty of birds, the music of their song, the weird wildness of their call, the majesty of their soaring flight, and the mystery of their migration, always have been subjects of absorbing interest to poets, artists and lovers of nature." Certainly much of the appeal, beauty, and charm of literature, art, and music would be lost if shorn of their allusions to birds.

Although their esthetic and recreational worth constitutes, perhaps, their greatest value to mankind, birds have also tremendous economic potentialities to which consideration must be given. Probably more than half the food of the 1,400 species and varieties of North American birds consists of insects. That the aggregate number of insects consumed is enormous no one can question. Yet the significance and effectiveness of such feeding as a factor in insect control are matters far more difficult to appraise. Ordinarily, climate, disease, and parasites are equally or possibly more important as natural checks on most pest species of insects, but entomologists and ornithologists agree that the insectivorous birds, through

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their feeding habits, render incalculable aid to agriculture, horticulture, and forestry.

The greatest value of birds in the role of insect destroyers lies in the coordination of their feeding activities with all other natural factors of the environment in preventing the development to plague proportions of destructive insect eruptions. Birds aid in maintaining an equilibrium in the biotic complex. Their repressive influence is constantly exerted, and their great mobility and propensity to wander causes them to concentrate at the scene of any local outbreak. Frequently, they not only control a pest, but almost effect its local extirpation. Thus they level off the waves of insect abundance and tend to maintain uniformity in numbers. W. L. McAtee ^{2/} has given many examples of the effectiveness of birds in the control or suppression of insect outbreaks and has pointed out that, realizing this, entomologists had much to do with the establishment of economic ornithology in this country and have constantly maintained their interest in it

Although birds often exert an important degree of control on insects over an extensive area, it is usually only in very limited sections that they actually suppress them. In widespread invasions, for example, the grasshopper plagues of recent years in the Central and Western States, birds, and other predatory agents are not sufficiently numerous to exert any noticeable control. Under these conditions other factors, as unfavorable climate, fungus and other diseases, or artificial control (Poisons), must be relied upon.

As a control agency, birds, of course, are not wholly effective, as they do not kill all the pests, but the same is true of every other control measure, biological or artificial. It has been stated that because of the great fecundity of insects in comparison with that of birds, the work of the latter cannot be very effective. Excursions into the realm of mathematics to demonstrate the inestimable number of progeny that may be produced from a single pair of insects profit little, as a continued unchecked increase never occurs. Those resorting to mathematical arguments fail to recognize the importance of the various insect predators, including birds, working in conjunction with all other natural and environmental factors when insects are present in normal numbers. Birds have a high rate of metabolism, which gives them a most impressive consuming capacity. A bird may destroy more insects at a single feeding than individual parasites destroy in a lifetime. Furthermore, birds continue to feed during seasons when unfavorable temperatures render insect parasites of little or no value as control agents.

The sea gull-cricket episode in Salt Lake Valley in 1848, which saved the lives of the early Mormon pioneers, is perhaps one of the best-known instances of effective control by birds of a serious insect pest. In 1855 a similar but less serious and less conspicuous incident occurred in the same valley when another cricket plague developed, which was again suppressed by the California gull early enough in the summer to permit a second

^{2/} McAtee, W.L. Local suppression of agricultural pests by birds. Smithsn. Inst. Ann. Rpt. 1920; 411-438, 1922. The role of vertebrates in the control of insect pests. Smithsn. Inst. Ann. Rpt. 1925; 415-437, 1926.

planting and a fairly successful harvest. The beautiful Sea Gull Monument on Temple Square in Salt Lake City, erected at a cost of more than \$40,000 in grateful remembrance of the services of these birds in delivering the early Utah pioneers from a cricket plague, is indeed a fitting tribute to the California gull.

In order to capitalize on the control ability of birds, many farmers in the West drive chickens and, more commonly, turkeys into their infested fields.

Undoubtedly, most of the successful attacks upon developing insect hordes go unnoticed because birds and other insect predators wage unceasing warfare to obtain sustenance, not for the purpose of assisting man. They often feed indiscriminately upon both valuable and harmful insects, but many species show definite preferences for certain destructive insects, as indicated by the yellow-billed cuckoo's extensive feeding on tent caterpillars and the palm warbler's common avoidance of the valuable ladybird beetles while feeding on destructive lepidopterous larvae. To show that control is a continuous process some recent examples may be cited.

Concerning the suppressive action of woodpeckers against Englemann spruce beetles on the Kootenai National Forest, Idaho, Tom T. Terrel, of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, in a recent memorandum, made the following statement, which has been confirmed by subsequent investigation:

"In 1937 a severe infestation of the Englemann spruce beetle was reported to be depleting stands of spruce in the Pinkham Creek drainage on the Kootenai National Forest . . . During the time of the second examination in June 1938, rather large groups of infested spruce were found with overwintering brood. Woodpecker activity, however, had destroyed the brood to such an extent that the source of potential reinfestation was reduced to protected brood below the snow line and it was predicted that very little reinfestation would occur."

Commenting on this same infestation, James C. Evendon, also of the Bureau of Entomology and Plant Quarantine, in a letter dated January 24, 1940, says:

"In June 1938 it was estimated that there were from 1,200 to 1,500 infested trees in this area. At the time of Mr. Terrel's examination, there was from four to six feet of snow within the area. Woodpeckers had removed a large percentage of the bark from all trees above the snow line and it is believed that perhaps 75 to 80 percent, or even more, of the broods above snow line had been destroyed. We have observed that woodpeckers concentrate upon the most heavily infested trees, which allow the greatest returns for their labor, so on trees where all of the bark is not removed, we usually find that there is a very poor brood and sometimes none at all."

In the summer of 1935 insects were attacking crops of benne (a good wildlife food) in the Thomasville, Ga., area, and Herbert L. Stoddard asked the Biological Survey for information on the control of pests. Before the

desired information was obtained, Mr. Stoddard wrote that the pests had largely disappeared, seemingly as a result of the great concentration of birds in the infested area.

In an address before the National Association of Audubon Societies on October 29, 1935, S. A. Rohwer, Assistant Chief of the Bureau of Entomology and Plant Quarantine, said:

"Examples of the part birds play in the control of insect pests are numerous. More than 40 species of the native wild birds prey on the true army worm, and similar numbers feed on the fall army worm or grass worm of the South. A specialist of the Bureau of Entomology and Plant Quarantine working in the Southeastern States recently recorded numerous observations which indicate that woodpeckers feed so extensively on the corn earworm, removing the worms from the ears before they have penetrated into the grain, that in certain seasons and localities they give a fair measure of control. In California another specialist reports that red-winged blackbirds fed so extensively on the valley grasshopper in the Sacramento Valley that the potential numbers for 1936 were reduced from 15 to 30 percent."

Ralph C. Hall, of the Bureau of Entomology and Plant Quarantine, and three assistant research entomologists made a detailed study of the locust borer in the North Central States from 1931 through 1937 and concluded that "Woodpeckers are important predators of the locust borer larvae in that region. In 1937 they were responsible for the removal of 29.4 percent of the spring borer population of the nine-year old Cambridge (Ohio) stand. They also removed about 20 percent of the larvae population of two four-year old Cambridge sprout plots. Locust borer survival was reduced by 20 percent in the Cambridge area in 1937 by this predator. This was approximately the same as for the previous three years in the area." In other areas the birds were much less effective. Dr. Hall added that "Hairy and downy woodpeckers feed heavily upon young larvae in early spring, shortly after inception of spring larval activity," and that for four years they "removed approximately 30 percent of the active population. In the pre-pupal and pupal stages a certain amount of control is exerted by the feeding of red-headed woodpeckers... It is possible that they are even more of a control factor farther south where they are more abundant." He concluded that parasites are relatively insignificant as a control factor and much less effective than birds.

The value of birds in controlling the most destructive insect pests of the celery crop in the vicinity of Sanford, Fla., is worthy of note. The economic importance of celery growing in that area is evidenced by the fact that a population of about 20,000 inhabitants depends (directly or indirectly) almost solely on that crop as a means of livelihood. Approximately one-third of the entire celery crop of the United States is produced on this narrow strip of land bordering Lake Monroe and Jessup. During the period that the Bureau of Biological Survey and the Bureau of Entomology and Plant Quarantine were making a cooperative study of the feeding activities of birds in that area, more than 2,200,000 crates of celery were harvested annually in Florida. At least three-fourths of that quantity was produced in the vicinity of Sanford, where it brought the celery growers from \$1.25 to \$4.25 a crate.

By far the most destructive insect pest that damaged the celery crop during the period of the study was the celery leaf-tier (Phlyctaenia rubigalis).

the larvae of which devoured the celery leaves in large numbers. Two other types of moth larvae, namely the celery looper (Autographa falcifera) and the cutworm (Phalaenidao) also caused considerable damage. The damage is most severe during mild winters when the temperature averages a little above normal throughout the growing season, which extends from December to the end of March. The harvest continues until late in April, and occasionally a late crop is harvested in June.

E. D. Ball, who conducted a detailed study of the celery insect pests for the Florida State Plant Board, reported that during warm weather three insect parasites helped to keep the celery leaf-tier in check. By far the most important of these is a tiny black wasp (Trichogramma minutum), which lays its eggs in the eggs of the leaf-tier. During a normal winter, however, this wasp becomes inactive for several months, and since most of the celery growth takes place during that period, an influx of migrant birds serves as the principal natural control on the insect pests.

Four species of birds were found to be of primary importance in the control of the celery leaf-tier. These were the palm warbler (Dendroica palmarum), tree swallow (Iridoprocne bicolor), red-winged blackbird (Agelaius phoeniceus), and, near the end of the harvesting season, the bobolink (Dolichonyx oryzivorus).

The palm warbler was more widely distributed in large numbers throughout the celery area during the entire growing season than any other bird. The western race (D. p. palmarum) outnumbered its eastern relative, the yellow palm warbler (D. p. hypochrysa), by about 25 to 1. These birds were occasionally found in the woods, but typically they are lovers of open fields with brushy borders or scattered trees.

The palm warblers showed little fear of man and were active in the celery fields throughout the day, feeding even during the midday heat, when most other birds remained quiet. Twenty-three of these Warblers were collected for stomach examination, and 22 of them were found to contain celery leaf-tiers in all stages of metamorphosis. This insect pest made up 73.14 percent of the total volume of food eaten by the palm warblers, and other lepidopterous pests (chiefly cutworms) composed an additional 6.09 percent. Some of the stomachs contained as many as 34 leaf-tiers; the average for the series was 13. The birds worked far down among the stems of the celery plants and removed the insects with surprising thoroughness.

Tree swallows also rendered great service in reducing the number of insect pests. The celery crop was commonly dusted with pyrethrum in an effort to drive out the adult leaf-tiers. When the dust was applied to the celery the moths could dart into the air in short flights and then drop back into the field. This procedure was continued until the insects finally escaped from the dusted area. The beginning of dusting operations in any field served as a signal for all the tree swallows in the vicinity to concentrate over the infested area. Hundreds would swarm around the duster and hover near it as it traversed the fields. Dr. Ball stated that the effectiveness of pyrethrum in controlling the adult leaf-tiers was proportionate to the assistance given by swallows. In one series of observations made while lying prone between the celery rows he found that only 2 of the first 100 moths that arose during dusting operations escaped the remarkable

accuracy of these aerial feeders. If a moth was missed on the first scoop a second attempt would usually land it in the swallow's gullet. Stomach examination furnished further evidence of this feeding ability. A well-filled tree-swallow stomach was found to contain 62 leaf-tier moths, which formed 96 percent of the total contents.

Red-winged blackbirds were likewise found valuable in controlling the larvae and pupae of the leaf-tier. It was not unusual to find 40 to 50 of these pests in a single blackbird stomach, and one contained 65. Celery leaf-tiers and loopers made up 55.33 percent of the food of 27 blackbirds collected around the celery fields; several other pests, including many cutworms, also composed an important part of the diet of the redwings.

Near the end of the growing season large numbers of bobolinks stopped in the celery area while on their northward migration after wintering in South America. They remained in the fields during the latter half of April and early May, gorging on the larvae and pupae of the leaf-tier. More than 71 percent of the food of 14 of these birds collected around the celery fields was composed of leaf-tier larvae and pupae, as many as 42 being found in a single stomach. Every bobolink collected had fed extensively on leaf-tier larvae, and many had taken considerable numbers of loopers as well.

In addition to the four species of celery-field birds mentioned, many others were found feeding, to an important degree, on celery insect pests. Among these both the purple and the boat-tailed grackle were outstanding for their valuable work on the cutworms. Dayton Stoner has continued the studies of birds of the celery fields and has submitted an extensive manuscript on the subject (not yet published).

In concluding, it is fitting to quote a statement ^{3/} by three experienced and well-known entomologists who had studied the insect pests of the Florida celery crop for several years--E.D. Ball, B.L. Boyden, and W.E. Stone:

"In a normal season the birds are plentiful enough to keep the celery leaf-tier entirely under control in the isolated fields and those adjoining woodlands. In the solidly planted areas where there is little shrubbery to afford the birds protection they appear in smaller numbers and if the infestation is very great there will not be birds enough to take care of it. Much could be done to encourage the birds by the planting of small, shrubby trees like the haw or wild plum along the ditch banks in the solidly planted areas. It might even be possible to set aside small strips of a mile or so apart as bird refuges."

These statements are in entire agreement with the observations the writers have made during the course of extended field studies in agricultural areas. They are only a few of many examples that could be given to show the economic value of birds and the help they render in controlling insect depredations.

^{3/} Florida Expt. Sta. Bull. 250, p. 11, 1932;